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(54) ELECTRICALLY INSULATING INSERT FOR PIPE LINES

(71) We, EISENBAU ALBERT ZIEFLE K.G., a company organized and existing under the laws of Federal Republic of Germany, of Oststrasse 17, 7640 Kehl, Federal Republic of Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention concerns an insulating insert for pipe lines that are made of electrically conducting material, the insert comprising two pipe pieces that are joinable to pipe line sections, as by welding, and are mechanically locked together and sealed against each other, at least one of the pipe pieces being coated with electrical insulation on all sides, except at the location for joining to a pipe line section.

An insulating insert of the type just described is known from German Utility Model No. 72 08 401, in which the pipe pieces have the form of flanged pieces and the flange of one has a frusto-conical outer surface and is drawn against the flange of the other by means of a tension collar, one end portion of which has an internal frusto-conical seating surface fitting the frusto-conical outer surface of one of the flanges, its other end portion being anchored on the other flanged piece. The two flanged pipe pieces and the tension collar are coated with a thermoplastic resin. Before assembly, the frusto-conical outer surface of the one flanged piece and the inner frusto-conical seating surface of the collar are provided with a supplementary coating of adhesive. Upon assembly, the flanged pieces are drawn together axially by the tension collar, at which time a strong surface compression of the thermo-plastic coating is produced. The thermoplastic material of the coating tends, in the course of time, to flow under the influence of the strong surface pressure load on

the coating, as the result of which both the mechanical tightness as well as the electrical breakdown strength are heavily impaired.

In French patent Specification No. 1 590 830, another insulating insert of the kind mentioned in the introduction was disclosed in which flanged pipe pieces of the insert are coated with heat-hardened epoxy resin and are drawn against each other axially by tension screws. The facing end surfaces of the flanged pipe pieces are hollowed out in their outer portions to form an annular chamber which, after the drawing together of the two flanged pieces, is flooded with a flexible elastic synthetic resin mass, in order to assure the required electrical breakdown resistance of the insulating insert. The flooding of the cavity of the insulating insert with the synthetic resin mass involves a relatively high cost and also involves difficulties, particularly when the insulating insert is assembled at a construction site. After the insulating insert is once flooded with the synthetic resin mass, it can no longer be taken apart without substantial impairment of the insulation.

It is an object of the present invention to provide an insulating insert of the kind mentioned in the introduction that can be economically produced from few components and nevertheless exhibits excellent qualities, both of fluid tightness and of electrical breakdown resistance, even when it is exposed for long periods to high temperatures.

Briefly, the insert of the present invention is distinguished by having at least one of the two pipe pieces coated with an insulating layer of a heat-hardened thermosetting resin composed of an epoxy resin base cross-linked by an addition reaction with a polyester resin containing carboxyl groups. The thermosetting epoxy-polyester resin coating provided in accordance with the invention is distinguished by a high electric breakdown

strength (far above 50 kV per mm of layer thickness) and has no tendency to flow even under the effects of high surface pressures and at temperatures up to 200°C and, moreover, at the same time has good elasticity and outstanding chemical stability.

For applying the insulating layer on a pipe piece, a powder mixture of epoxy resin, polyester resin and a suitable hardener is used, which may contain also, according to the requirements of the particular case, a filler and/or additives that facilitate the sintering together of the powder particles. The powder mixture is applied to the pipe piece by an electrostatic powder coating method while the pipe piece is heated at the same time, so that the powder particles harden on the pipe piece into a thermosetting epoxy-polyester resin layer. The electrostatically applied powder particles penetrate at once into the finest pores and fill these in hardening, so that on account of the absence of solvents, no voids remain to impair the dielectric strength opposing electrical breakdown.

Preferably the coating powder consists essentially of 30% by weight of epoxy resin, 30% by weight of polyester resin containing carboxyl groups, 33% by weight of filler and the remainder of hardening agent and additive for promoting coalescence of the powder particles. The filler can, as suits the occasion, be replaced in whole or in part by epoxy resin.

A coating powder particularly suitable for the production of the insulating layer is made available by the firm C.W.S.-Lackfabrik, 5160 Duren, Germany, under the designation EP 2019. This coating powder consists of the following components:

- 30% by weight of epoxy resin with an epoxy-equivalence between 800 and 950 and a melting point of 70-80°C,
- 30% by weight of functionally hydroxyl-saturated, acid polyester resin, having a melting point of 60-70°C as determined according to German norm DIN 53 181 and an acid number of 60-80 determined according to German norm DIN 53 402, and a small content of epoxy resin, as well as an anhydride soluble in polyester resin, as hardener for the epoxy resin,
- 33% by weight of titanium dioxide, serving as filler, and
- 6% of spreading agent and waxes for facilitating the coalescence of the powder particles.

The application of the insulating layer to a pipe piece of the insert is preferably carried out in a fluidized bed produced by turbulent agitation of the coating powder, where the powder particles are electrostatically precipitated on the surface of the heated pipe piece to build up the insulating layer. The hardening of the applied insulating layer is produced

by heating to 180 to 200°C for a duration of 8 to 15 minutes. The thickness of the insulating layer is preferably from 0.5 to 0.6 mm. An electrostatically applied insulation layer with a thickness of 0.5 mm has a dielectric strength of over 50 kilovolts, because it is free of cavities impairing the dielectric strength.

The invention is further described by way of illustrative examples to explain advantageous features with reference to the accompanying drawings, in which:

Figs. 1 to 4 are longitudinal sections through embodiments of the invention, in which flanged pipe pieces are used that are drawn together by a tension collar, only the section of the pipe piece on one side of the axis of symmetry being shown;

Fig. 5 is a longitudinal section similarly showing an embodiment of the invention in which flanged pipe pieces are drawn together by tension bolts, and

Figs. 6 and 7 are longitudinal sections respectively through embodiments of the invention in which unflanged pipe pieces are bound together by means of a shell pushed over their adjoining ends.

The preferred embodiment represented in Fig. 1 comprises two flanged pipe pieces 1 and 2 made of steel that can be welded, by means of pipe stubs 3, respectively onto steel pipe line sections. One of the flanged pipe pieces 1 has a frusto-conical outer surface 4 that preferably is at an angle of 15° with the central axis running along the middle of the pipe. The flange pipe piece 1 is coated with a heat-hardened insulating layer 5 of epoxy-polyester-resin base that extends over the inner surface 6, the end surface 7 and the outer surface 4 of the flanged piece 1 and over a part of the stub pipe 3. The insulating layer is applied to the flanged piece 1 by electrostatic powder coating under simultaneous heating of the flanged piece. The coating powder contains as the base resin an epoxy resin and as a cross-linking agent, a polyester resin containing carboxyl groups. As soon as the powder particles impinge on the heated flange piece, an addition reaction takes place as the result of the heat then present and, in consequence, cross-linking into a thermosetting resin. The insulating layer 5 possesses preferably a thickness of only 0.5 to 0.6 mm and with such a thickness has a dielectric strength of over 50 kV.

The two flanged pieces 1 and 2 are axially drawn together by a tension collar 8. One-half of the inner surface of the collar 8 is cylindrical in shape and fits the outer diameter of the flange of the flanged piece 2, while the other half of the inner surface of the collar 8 is shaped as a frusto-conical seating surface 9 and fits the frusto-conical outer surface 4 of the flanged piece 1.

For obtaining good tightness that remains

constant even under high internal pressure, there is additionally provided, between the oppositely facing end surfaces of the flanged pieces, a simple O-ring seal. For this purpose, an annular groove 11 is machined into the end surface of the uncoated pipe piece 2 and a sealing O-ring 12 of elastic material is seated in the groove. This O-ring seal between end surfaces of the flanged pieces 1 and 2 facing each other provides an excellent primary seal. This primary seal cooperates with a secondary seal provided behind it, formed by the insulating layer confined between the frusto-conical seating surface 9 of the tension collar 8 and the frusto-conical outer surface 4 of the annular flange of the pipe piece 1. This insulating layer is under strong surface pressure and assures that any fluid that might possibly leak through the primary seal cannot reach the outside.

The assembly of the insulating insert shown in Fig. 1 is simply performed by standing the uncoated flanged piece 2 on a support tube, seating the O-ring 12 in the now horizontally disposed ring groove 11, setting the flanged piece 1 on the other flanged piece 2, pushing the tension collar 8 from above over both flanged pieces 1 and 2 and pressing downward by means of a tube grasping the upwardly disposed side surfaces of the collar 8 in order to assure the desired surface compression of the insulating layer between the flanged piece 1 and the collar 8. The downwardly disposed end of the collar 8 is then connected with the lower flanged piece 2 by an end weld seam 10 to maintain the surface pressure. Since the thermosetting insulating layer has no tendency to flow, the required axial tension drawing the two flanged pieces together is preserved to provide a trouble-free seal and unimpaired dielectric strength. An insulating insert assembled as shown in Fig. 1 having a nominal diameter of 100 mm can contain a test pressure of 250 kg/cm² and can withstand a test voltage of 12 kV without difficulty.

The embodiment shown in Fig. 2 differs from the preferred embodiment shown in Fig. 1 in that a supplementary insulating ring 13 of pressure-resistant electrically insulating material is provided between the flanges of the pipe pieces 1 and 2. This supplementary insulating washer 13 has a groove 14 on each side face in which an O-ring of elastic material is seated to provide the primary seal of the joint. The ring grooves 14 can of course be provided in the end faces of the flanged pieces 1 and 2, instead of in the insulating washer 13.

The embodiment illustrated in Fig. 3 differs from that of Fig. 1 with respect to the anchoring of the tension collar 8 on the flanged piece 2. As shown in Fig. 3, the end of the collar 8 extending over the flange of the piece 2 has internal screw threading 16 in

which an externally threaded ring 17 is screwed that bears against the flange of the piece 2 and provides the necessary axial pressure.

The embodiment illustrated in Fig. 4 differs from that of Fig. 2 in that instead of the welded joint between the tension collar 8 and the flanged pipe fitting 2, a screw thread fastening is provided. The outer surface of the flange fitting 2 has external threads 18 cut therein that are engaged with the internal threading 19 provided in the cylindrical half of the tension collar 8.

The embodiment illustrated in Fig. 5 is composed of two identical flanged pipe fittings 20, 21 made of steel that can be welded to steel pipe line sections at their extending pipe stubs 22. The flanged fittings are spaced from each other near the outer edges of their flanges and are provided there with aligned axial bores in the respective fittings for receiving tension bolts 24.

Each of the two flanged fittings 20 and 21 is coated with an insulating layer 25 that extends continuously over the inner surface, end surface and outer surface of the fittings, as well as the inner walls of the bores 23 and thus covers the flanged fittings on all sides with the exception of the end of the pipe stub 22 provided for a joint to a pipe line section. The insulating layer consists of a heat-hardened thermosetting resin of an epoxy resin base cross-linked by an addition reaction with a polyester resin containing carboxyl groups and is preferably applied as explained previously, by electrostatic powder coating during concurrent heating of the flanged fitting. The insulating layer preferably has the thickness of only 0.4 to 0.6 mm.

The coated flanged fittings 20 and 21 are fastened together under axial pressure by means of the tension bolts 24 passing through the bores 23, so that the insulating layer located on the faces of the flanged fittings are closely pressed against each other. Although it is not strictly necessary, as a practical way of increasing the dielectric strength margin of safety, a washer 26 of a pressure-resistant electrical insulating material is provided between the opposite faces of the flanged fittings 20 and 21.

In order to prevent damage of the insulating layer applied to the flanged fittings 20 and 21 when the tension bolts are tightened down, there is provided a washer 27 of pressure-resistant electrical insulating material between each bolt head and the flanged fitting 21 and likewise between the corresponding nut and the flanged fitting 20. Further coating of the bolt shaft with electrically insulating material or the provision of an insulating tube in the flush fitting axial bore 23 can be dispensed with, since the insulating layer 25 extending continuously over the inner walls of the bores 23 provides

sufficient insulation.

In case the insulating insert assembly of Fig. 5 is to be inserted in a pipe line with an internal pressure of more than 50 kg/mm², it is to be recommended that the end face of one of the two pipe fittings 20 or 21 should be provided with an O-ring seal. Such an O-ring seal is likewise desirable if the insulating insert assembly is used in pipe lines having a diameter of the order of magnitude of 200 mm and greater. For such an O-ring seal, a ring groove is machined into one of the flanged fittings of each insert before the application of the insulating layer and only thereafter is the insulating layer put on. Then, when the insulating insert is assembled, an elastic O-ring of corresponding size is set into the ring groove. An O-ring seal assures that the insulating insert remains absolutely fluid tight under the axial compression of its assembly in the particular cases of loading with high internal pressures for use in pipe lines with large internal diameters.

The insulating insert assembly shown in Fig. 6 has two identical seal pipe pieces 28 which, in contrast to the embodiments of Figs. 1 to 5, have no perpendicularly extending annular flange. Each of the two flangeless pipe fittings 28 is coated with an insulating layer 29 of epoxy-polyester-resin base which covers the pipe piece on all sides except for the end region 30 that is weldable to a pipe line section. The insulating layer is applied in the manner already described by use of a powder mixture of epoxy resin, polyester resin and a suitable hardener and such additives as may be selected, if any, for facilitating the coalescence of the powder particles, the coating being applied electrostatically on the pipe fitting with concurrent heating of the fitting. The two coated pipe fittings 28 are held together with adhesive at their oppositely adjacent end faces by means of an electrically nonconducting adhesive 32 that may be either a cold hardening or a hot hardening adhesive. A tubular steel shell 33 is slid over the two coated pipe pieces 28, the inner diameter of the shell 33 being only slightly greater than the outer diameter of the pipe pieces 28, so that a narrow annular gap 34 remains between the pipe fittings 28 and the shell 33, which is filled with an electrically nonconducting adhesive that may be either cold hardened or hot hardened. The shell 33 is located symmetrically with respect to the cemented end surfaces of the pipe fittings 28, so that one pipe fitting is enclosed by one-half of the shell and the other by the other half of the shell. The length of the shell 33 is selected in view of the cementing strength of the adhesive provided in the annular gap 34, so that the insulating insert assembly has sufficient resistance to pulling, bending and torsion stresses for the pipe line requirements.

The embodiment illustrated in Fig. 7 differs from that shown in Fig. 6 merely in that the coated facing end surfaces of the two pipe fittings 28 are not cemented to each other, but rather are separated by a seal ring 35 of a pressure-resistant, elastic and electrically non-conducting material, preferably a hard rubber composition, provided between the facing end surfaces of the coated pipe pieces 28. The interposed seal ring 35 provides trouble-free fluid tightness of the insulating insert assembly. In the assembly of the insulating insert of Fig. 7, the two coated pipe fittings 28, with the seal ring 35 interposed between them, are put under axial compression, while the shell 33 is slid over the compressed assembly and thereafter firmly cemented thereto.

The shell 33 provided for the embodiments illustrated in Figs. 6 and 7 can, if desired, also be coated on all sides with an insulating layer of epoxy-polyester-resin base of the kind above described, in order to provide a particularly high dielectric strength for the insulating insert. The thickness of the insulating layer provided on the pipe fittings 28 and also the thickness that may optionally be applied to the shell 33 is preferably from 0.5 to 0.6 mm.

The insulating inserts of the kind shown in Figs. 6 and 7 are particularly suitable for pipe lines with a nominal diameter from 12.5 to 300 mm, in which the operating pressure goes up to about 50 kg/mm². Insulating inserts according to Fig. 6 or Fig. 7 are particularly economical to produce and nevertheless are distinguished by outstanding mechanical and electrical properties.

WHAT WE CLAIM IS:

1. An insulating insert for pipe lines made of electrically conducting material, comprising two pipe pieces capable of being tightly joined onto pipe line sections, which pipe pieces are mechanically held fast together and sealed against each other, and at least one of which, for electric insulation of each piece from the other, is coated with an insulating layer except at the location for joining to a pipe line section, further having the improvement which consists in that: the insulation layer applied to at least one of the pipe pieces consists essentially of a heat-hardened thermosetting resin composed of an epoxy resin base cross-linked by an addition reaction with a polyester resin containing carboxyl groups.
2. An insulating insert for pipe lines as defined in claim 1, in which said insulation layer is a layer formed of electrostatically applied material.
3. An insulating insert for pipe lines as defined in claim 1, in which said pipe pieces respectively have ring flanges at the ends where they face each other, in which, further, an annular groove is provided in the end face

of the ring flange of one of said pieces and in which a sealing O-ring is seated in said groove to provide a seal between said pipe pieces.

5 4. An insulating insert for pipe lines as defined in claim 1, in which said pipe pieces are respectively provided with ring flanges at their ends that face each other, and in which, further, a supplemental insulating ring of
10 pressure-resistant electrical insulating material is provided between the facing flanged ends of said pipe pieces.

5. An insulating insert for pipe lines as defined in claim 4, in which an annular
15 groove is provided on each of the end faces of said supplemental insulating ring, and in which, further, a sealing O-ring is seated in each of said annular grooves.

6. An insulating insert for pipe lines as defined in claim 1, in which said pipe pieces
20 are respectively provided with ring flanges at their ends that face each other and that the ring flange of one of them has a conical outer surface, and in which, further, the other of
25 said flanged pipe pieces is uncoated and is pressed against the coated pipe piece of which the flange has a conical outer surface by means of a surrounding tension collar having an internal conical seating surface engag-
30 ing the conical surface of said coated flanged pipe piece and having its other end fastened to the uncoated flanged pipe piece.

7. An insulating insert for pipe lines as defined in claim 6, in which said tension col-
35 lar is fastened to the uncoated flanged pipe piece by an end weld joint.

8. An insulating insert as defined in claim 6, in which said tension collar is fast-
40 ened to the uncoated flanged pipe piece by a screw connection.

9. An insulating insert for pipe lines as defined in claim 6, in which said tension col-
45 lar is provided with internal screw threads at one end in which an externally threaded ring is screwed in against the rear side of the

flange of the uncoated flanged pipe piece.

10. An insulating insert for pipe lines as defined in claim 6, in which said tension col-
50 lar is screwed onto the flange of the uncoated flanged pipe piece.

11. An insulating insert for pipe lines as defined in claim 3, in which both of said
55 flanged pieces are coated with an insulating layer and are drawn against each other axially by tension bolts that pass through bores located near the outer circumferential edge of the flanges, the outer portions of the
60 respective flanges in which said bores are located being spaced from each other by a gap when the insert is assembled.

12. An insulating insert for pipe lines as defined in claim 1, in which each of said pipe
65 pieces is coated with a said insulating layer and both said pieces are fastened by an adhesive to a close-fitting shell pushed over the adjoining ends of said pipe pieces, a part of
70 said shell fitting around one of said pipe pieces and the remaining part of said shell fitting around the other.

13. An insulating insert for pipe lines as defined in claim 12, in which the facing end
75 surfaces of the pipe pieces are fastened together with adhesive.

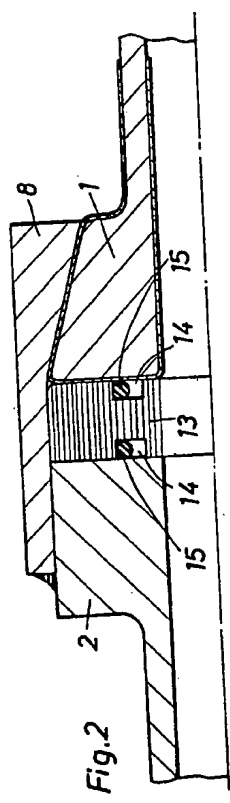
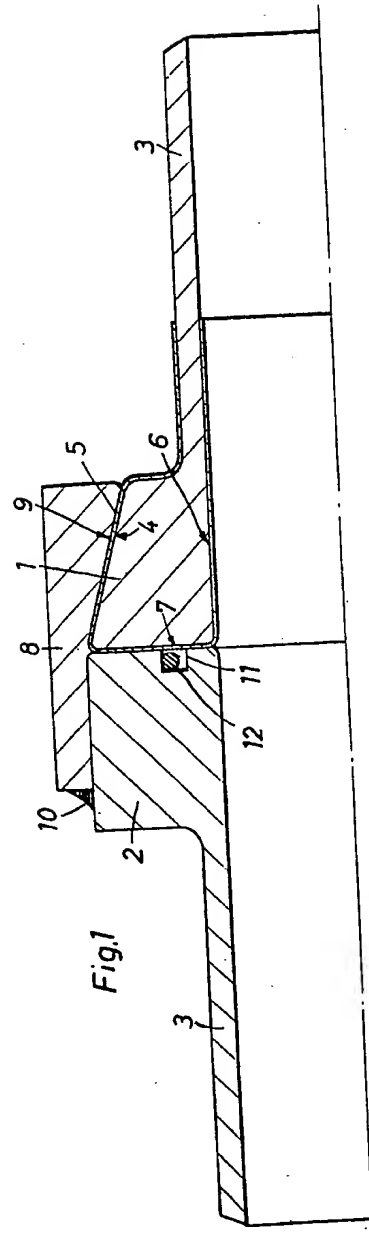
14. An insulating insert for pipe lines as defined in claim 12, in which a seal ring of
80 pressure-resistant, elastic, electrically insulating material is provided between the opposite facing end surfaces of said pipe pieces.

15. An insulating insert for pipe lines, substantially as hereinbefore described with
85 reference to, and as illustrated in, any Figure of the accompanying drawings.

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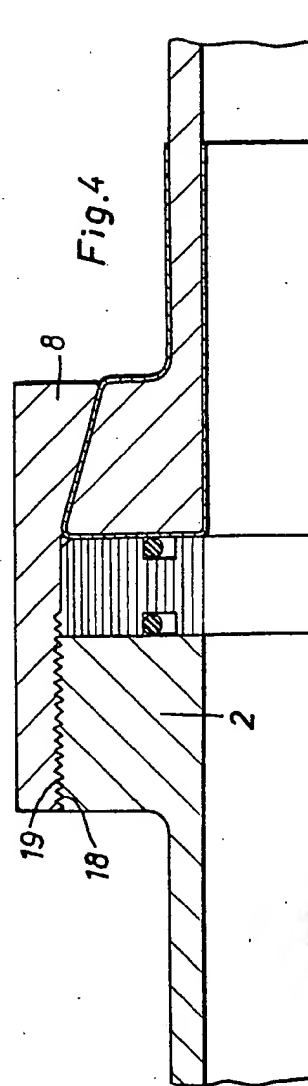
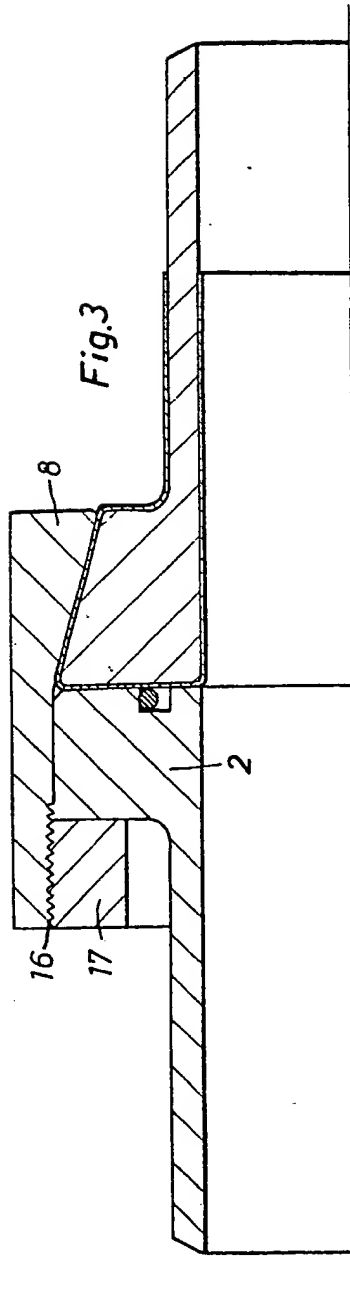
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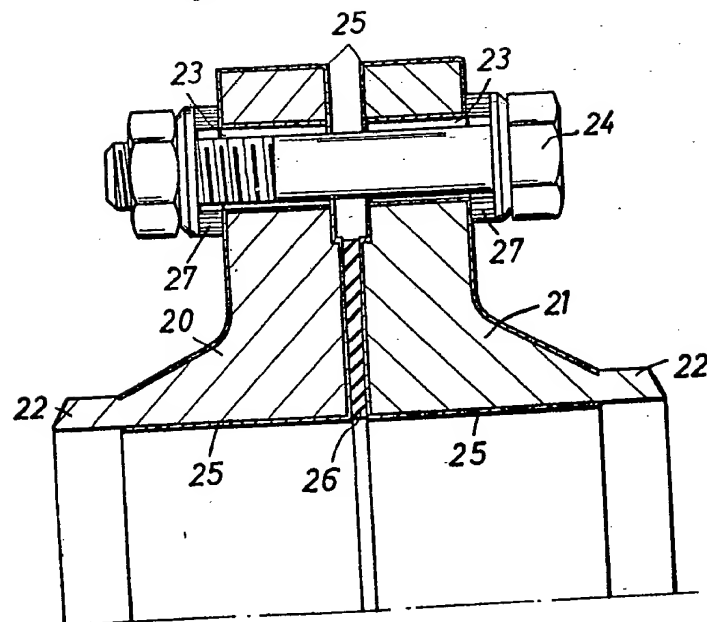
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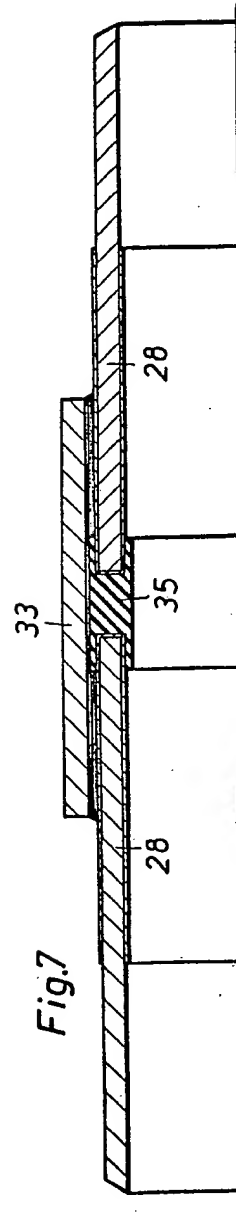
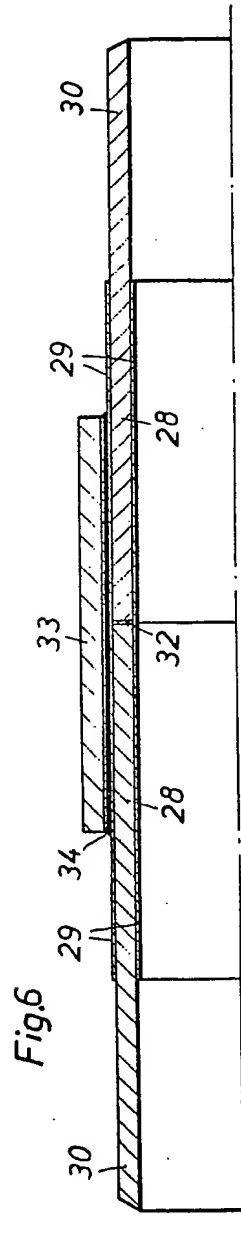
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SHEET 3

Fig.5





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